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# Evaluation of nanoparticle-based fluids with regard to the enhanced oil recovery (EOR) efficiency and energy cost of their synthesis

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Two different types of polymer-coated nanoparticles (PNPs) were synthesized, stabilized in aqueous solutions of salts (NaCl, CaCl2) and used to prepare Pickering oil-in-water emulsions for enhanced oil recovery (EOR) from reservoir rocks: (1) PNPs of silica synthesized by free radical polymerization of the monomers 2-acrylamido-2-methyl-1-propanesulfonic acid (AMPSA) and dodecyl methacrylate (DMA) on the surface of acrylic-modified spherical silica nanoparticles [1]; (2) PNPs of iron oxide (IONP) synthesized by using the polyphenols extracted from plant leaves as reductants of ferric chloride hexahydrate or ferrous sulphate heptahydrate [2]. Visualization tests of the immiscible displacement of viscous paraffin oil by aqueous suspensions and emulsions were conducted in a transparent glass-etched pore network, and used to assess the performance of the various fluid systems as agents for EOR process, in terms of the oil recovery efficiency and an energy efficiency index.
The AMPSA-SiO2 PNPs were characterized by Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR) and thermogravimetric analysis (TGA). The structure of iron oxide nanoparticles was confirmed with X-ray diffraction (XRD) analysis, and scanning-electron microscope (SEM) images and energy dispersive X-ray analysis (EDX) of solid material isolated with centrifuging. The suspended nanoparticle size distribution was determined with dynamic light scattering (DLS), while the stability of the nano-colloids was confirmed by measuring the ζ-potential as a function of the ionic strength. The interfacial properties were measured by dynamic (pendant drop) and static (duNuoy) methods, whereas the wettability was quantified by measuring the oil/water contact angle on glass surfaces. With the aid of a high energy ultrasound probe, the PNP suspensions were mixed with oil (n-C10, n-C12) to prepare Pickering emulsions, the rheological properties (shear viscosity, loss and storage moduli) of which were measured on a stress rheometer, while their stability was inspected by observing the phase separation (macro-scale) and measuring the drop size distribution (micro-scale).
To assess the EOR efficiency, two-phase flow tests were conducted under constant flow rate in the following rank: (i) a drainage step, where the brine (salt solution) saturating completely the porous medium is displaced by paraffin oil; (ii) a primary imbibition step where the residual oil of the previous step is displaced by brine; (iii) secondary imbibition step, where the residual oil of the previous step is displaced by PNP-based fluid (Fig.1). The oil saturation was measured as function of time with image analysis of successive snap-shots captured by a CCD camera [3], and the transient response of the pressure drop across the porous medium was recorded with the aid of two pressure transmitters and a data acquisition card. Comparative analysis of the oil recovery efficiency and energy efficiency index, attained by all tested nano-colloid suspensions and Pickering emulsions, allowed us to classify them, and select the most efficient ones for further studies in reservoir rocks.

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## Participation

In-Person

## References


1. Ntente, C., Strekla, A., Iatridi, Z., Theodoropoulou, M., Bokias, G., and C.D. Tsakiroglou, "Polymer-functionalized nanoparticles as agents for the in situ remediation of oil-contaminated soils", Proceed. of the 3rd Intern. Conf. Environ. Design (ICED2022), 22-23 Oct. 2022, Athens, Greece.
2. Strekla, A., Ntente, C., Theodoropoulou, M., and C.D. Tsakiroglou, "Nano-colloid based suspensions and emulsions used as means for enhanced oil recovery", Proceed. of the 35th Intern. Symp. of the Society of Core Analysts (SCA), paper SCA2022-T085, 19-22 Sept. 2022, Austin, TX.
3. Theodoropoulou, M.A., V. Sygouni, V. Karoutsos, and C.D. Tsakiroglou, "Relative permeability and capillary pressure functions of porous media as related to the displacement growth pattern", Int. J. Multiphase Flow, 31, 1155-1180 (2005).


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